AD-A270 466

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NASA/DoD Aerospace Knowledge Diffusion Research Project

NASA Technical Memorandum 108987

Report Number 17

A Comparison of the Technical Communication Practices of Dutch and U.S. Aerospace Engineers and Scientists

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July 1993

69pp

KNOWLEDGE DIFFUSION NASA DoD AEROSPACE INNOVATION

NASA
National Aeronautics and Space Administration

Department of Defense

INDIANA UNIVERSITY

INTRODUCTION

Rapidly changing patterns of international cooperation and collaboration and revolutionary technological and managerial changes are combining to influence and transform the communication of technical information in the workplace. To contribute to our understanding of workplace culture, organization, and communications at the national and international levels, an exploratory study was conducted that investigated the technical communications practices of aerospace engineers and scientists at three similar research organizations in the Netherlands and the United States (U.S.). Previous work includes exploratory studies of the technical communications practices of aerospace engineers and scientists in Israel [1], Japan [2][3], selected Western European countries [4], Russia [5], and the U.S. [6][7].

The data reported herein were collected through self-administered questionnaires undertaken as a Phase 4 activity of the *NASA/DoD Aerospace Knowledge Diffusion Research Project*. The Dutch/U.S. study included the following objectives:

1. To solicit the opinions of aerospace engineers and scientists regarding the importance of technical communications to their profession,

2. To determine the use and production of technical communications by aerospace engineers and scientists,

3. To seek their views about the appropriate content of an undergraduate course in technical communications,

4. To determine their use of libraries and technical information centers,

5. To determine their use and importance of computer and information technology to them,

6. To determine their use of electronic networks, and

7. To determine their use of foreign and domestically produced technical reports.

BACKGROUND

Aerospace engineering exhibits particular characteristics which make it an excellent platform for studying technical communications in the international workplace. The aerospace industry is becoming more international in scope and increasingly collaborative in nature, thus creating a multinational manufacturing environment. International industrial alliances will result in a more rapid diffusion of technology in order to enhance innovation and increase productivity. Aerospace producers will feel growing pressure to push forward with new technological developments, to maximize the inclusion of those developments into the research and development (R&D) process, and to maintain and improve the professional competency of aerospace engineers and scientists. Meeting these objectives at a reasonable cost depends on a variety of factors, but largely on the ability of aerospace engineers and scientists to acquire, process, and communicate scientific and technical information (STI). Although studies indicate that access to STI can increase productivity and innovation and help aerospace engineers and scientists maintain and improve their professional skills, these same studies demonstrate that little is known about how aerospace engineers and scientists find and use STI or how aerospace knowledge is diffused. To learn more about this process, researchers at the NASA Langley Research Center, the Indiana University Center for Survey Research, Rensselaer Polytechnic Institute, and institutions in selected countries are studying aerospace knowledge diffusion. These studies comprise the *NASA/DoD Aerospace Knowledge Diffusion Research Project.* A project fact sheet appears in Appendix A.

Phase 1 of the project investigates the information-seeking behavior of U.S. aerospace engineers and scientists and places particular emphasis on their use of federally funded

aerospace R&D and U.S. government technical reports. Phase 2 examines the industry-government interface and emphasizes the role of information intermediaries in the aerospace knowledge diffusion process. Phase 3 concerns the academic-government interface and focuses on the relationships between and among the information intermediary, faculty, and students. Phase 4 explores patterns of technical communications among non-U.S. aerospace engineers and scientists in selected countries [8]. A list of *NASA/DoD Aerospace Knowledge Diffusion Research Project* publications appears in Appendix B.

RESEARCH DESIGN AND METHODOLOGY

The research was conducted at comparable aeronautical research facilities: the National Aerospace Laboratory (NLR) in the Netherlands, the NASA Ames Research Center in the U.S., and the NASA Langley Research Center in the U.S., using self-administered (self-reported) mail surveys. The instrument used to collect the data had been used previously in several Western European countries and Japan and in Russia in slightly adapted form. Questionnaires were distributed to 200 researchers at NLR, and 109 were received by the established cut off date for a completion rate of 55%. Questionnaires were distributed to 558 researchers at the two NASA installations, and 340 were received by the established cut off date for a completion rate of 61%. A follow-up survey containing additional questions about technical communications training, technical report use, and language skills was distributed to the U.S. respondents. (These questions were initially included in the Dutch survey.) Two hundred eighty-seven of the 340 U.S. respondents completed and returned the follow-up survey for an adjusted response rate of 84%. The survey at NLR was conducted during November and December of 1992, and the surveys at the NASA centers were

conducted during July and August of 1992 with the follow-up in December 1992. The survey instruments used in the Netherlands and the U.S appear in Appendixes C and D, respectively.

PRESENTATION OF THE DATA

This report presents selected results from the Dutch and U.S. studies, with the Dutch responses presented first, followed by the U.S. responses. Demographic data are presented first, followed by data dealing with the importance of technical communications, workplace use and production of technical communications, appropriate course content for an undergraduate course in technical communications, use of libraries and technical information centers, use of computer and information technology, use of electronic networks, and use of foreign and domestically produced technical reports.

Demographic Information About the Survey Respondents

Survey respondents were asked to provide information regarding their professional duties, years of professional work experience, educational preparation, current professional duties, and gender. These demographic findings appear in table 1. A comparison of the two groups reveals some differences and similarities. The two groups differ significantly in terms of organizational affiliation and professional/technical society membership; they are similar in years of professional work experience, current professional duties, amount and type of educational preparation, and gender.

The following "composite" participant profiles were based on the demographic data. The Dutch survey participant works as a researcher (63%), has a graduate degree (80%), was trained as an engineer (74%) and currently works as an engineer (75%), has an average of 12

Table 1. Demographic Findings

	Netherlands		U.S.	
	%	(n)	%	(n)
Professional Duties				
Design/Development	28	(30)	6	(21)
Administration/Management	3	(3)	11	(37)
Research	63	(69)	82	(279)
Other	6	(17)	1	(3)
Organizational Affiliation				
Government	100	(209)	100	(340)
Professional Work Experience				
1 - 5 years	38	(41)	15	(52)
6 - 10 years	15	(17)	22	(74)
11 - 20 years	22	(24)	28	(95)
21 - 40 years	25	(27)	34	(115)
41 or more years	0	(0)	1	(4)
Netherlands / U.S.				
Mean: 12 / 17				
Median: 9 / 14				
Education				
Bachelor's Degree Or Less	20	(22)	27	(91)
Graduate Degree	80	(87)	73	(249)
Educational Preparation				
Engineer	74	(81)	80	(273)
Scientist	25	(27)	17	(58)
Other	1	(1)	3	(9)
Current Duties				
Engineer	75	(82)	69	(234)
Scientist	22	(24)	27	(92)
Other	3	(3)	4	(14)
Member of A Professional/ Technical Society	46	(50)	78	(265)
Gender				
Female	4	(4)	15	(50)
Male	96	(105)	85	(290)

years professional work experience, and reads and speaks two foreign languages with considerable fluency. The U.S. survey participant works as a researcher (82%), has a graduate degree (73%), was trained as an engineer (80%), currently works as an engineer (69%), has an average of 17 years of professional work experience, and belongs to a professional/technical society (78%).

Survey respondents were also asked to provide information about their foreign language skills, specifically their reading and speaking competencies in the languages used by major international aerospace producers. These findings appear in table 2. All of the Dutch respondents (100%) read and speak English and German and read and speak French to a lesser extent (92%). The U.S. respondents reported little fluency in any foreign languages. Both groups reported little fluency in either Japanese and Russian. The mean ($\bar{X}$) ability to read and speak German and French was higher for the Dutch than for the U.S. group. The mean ($\bar{X}$) ability to read and speak Japanese and Russian, although low for both groups, was higher for the U.S. group.

Table 2. Foreign Language Fluency Among Dutch and U.S. Aerospace Engineers and Scientists

	Netherlands n = 109			U.S. n = 287		
Language	Read %	Speak %	$\bar{X}$ Ability[a]	Read %	Speak %	$\bar{X}$ Ability[a]
English	100	100	---- ----	b	b	---- ----
French	92	92	2.5 2.1	32	22	1.7 1.6
German	100	99	4.0 3.4	22	15	1.7 1.6
Japanese	7	6	1.0 1.0	4	5	1.7 1.7
Russian	8	5	1.0 1.0	7	5	1.6 1.6

[a] A 1 to 5 scale was used to measure ability with "1" being passably and "5" being fluently; hence the higher the average (mean) the greater the ability of survey respondents to speak/read the language.

[b] English is the native language for these respondents.

Importance of and Time Spent on Technical Communications

Approximately 91% of the Dutch respondents and 91% of the U.S. respondents indicated that the ability to communicate technical information effectively is important. (Importance was measured on a 5-point scale with 1 = very unimportant and 5 = very important; percentages = combined "4" and "5" responses.) The Dutch aerospace engineers and scientists spent an average of 15.6 hours per week communicating technical information to others; U.S. aerospace engineers and scientists spent an average of 16.98 hours per week. Dutch aerospace engineers and scientists spent an average of 11.65 hours per week, and U.S. aerospace engineers and scientists spent an average of 13.97 hours per week working with communications received from others (table 3). Considering both the time spent communicating information with others and working with communications received from others, technical communications takes up approximately 68% of the Dutch aerospace engineer's and scientist's 40-hour work week and 77% of the U.S. aerospace engineer's and scientist's work week.

Approximately 60% of the Dutch respondents and 70% of the U.S. respondents indicated that the amount of time they spent communicating technical information had increased over the

Table 3. Mean (Median) Number of Hours Spent Each Week By Dutch and U.S. Aerospace Engineers and Scientists Communicating Technical Information

	Netherlands	U.S.
Communication With Others	15.60 (15.00) hours/week	16.98 (15.00) hours/week
Working with Communications Received From Others	11.65 (10.00) hours/week	13.97 (12.00) hours/week
Percent Of Work Week Devoted To Technical Communications*	68%	77%

*Based on a 40-hour work week.

past 5 years (table 4). Thirty-five percent of the Dutch respondents and 24% of the U.S. respondents indicated that the amount of time they spent communicating technical information had stayed the same over the past 5 years. Only 5% of the Dutch respondents and 6% of the U.S. respondents indicated that the amount of time they spent communicating technical information had decreased over the past 5 years.

Table 4. Changes in the Past 5 Years in the Amount of Time Spent Communicating Technical Information by Dutch and U.S. Aerospace Engineers and Scientists

	Netherlands		U.S.	
	%	(n)	%	(n)
Increased	60	(66)	70	(239)
Stayed The Same	35	(38)	24	(80)
Decreased	5	(5)	6	(21)

As they have advanced professionally, 45% of the Dutch respondents have increased the amount of time they spend communicating technical information. Likewise, 65% of the U.S. respondents indicated that, as they have advanced professionally, they have increased the amount of time they spend communicating technical information (table 5).

Table 5. Changes in the Amount of Time Spent Communicating Technical Information as a Part of Professional Advancement by Dutch and U.S. Aerospace Engineers and Scientists

	Netherlands		U.S.	
	%	(n)	%	(n)
Increased	45	(49)	65	(221)
Stayed The Same	50	(54)	26	(87)
Decreased	5	(6)	9	(32)

The Production and Use of Technical Communications

The process of collaborative writing was examined as part of this study. Survey participants were asked whether they wrote alone or as part of a group (table 6). Approximately 24% of the Dutch respondents and 15% of the U.S. respondents write alone. Although a lower

Table 6. Collaborative Writing Practices of Dutch and U.S. Aerospace Engineers and Scientists

	India			U.S.		
	$\bar{X}$%	%*	(n)	$\bar{X}$%	%*	(n)
I Write Alone	64.8	24	(26)	61.1	15	(50)
I Write With One Other Person	20.1	65	(71)	20.7	72	(246)
I Write With A Group Of Two To Five People	12.6	49	(54)	15.6	61	(208)
I Write With A Group Of More Than Five People	2.5	10	(11)	2.1	14	(47)

* Percentages do not total 100

percentage of the Dutch than the U.S. respondents writes with a group of 2 to 5 people or with a group of more than 5 people, writing appears to be a collaborative process for both groups.

Dutch and U.S. aerospace engineers and scientists were asked to assess the influence of group participation on writing productivity (table 7). Only 28% of the Dutch respondents and 33% of the U.S. respondents indicated that group writing is more productive than writing alone. Nineteen percent of the Dutch respondents and 32% of the U.S. respondents found that group writing is about as productive as writing alone, and 25% of the Dutch respondents and 20% of the U.S. respondents found that writing in a group is less productive than writing alone.

Of the respondents who did not write alone, 49% of the Dutch group and 47% of the U.S. group worked with the same group when producing written technical communications (table 8). The average number of people in the Dutch group was $\bar{X}$ = 4.96 and the average number of

Table 7. Influence of Group Participation on Writing Productivity For Dutch and U.S. Aerospace Engineers and Scientists

	Netherlands		U.S.	
	%	(n)	%	(n)
A Group Is More Productive Than Writing Alone	28	(31)	32	(110)
A Group Is About As Productive As Writing Alone	19	(21)	31	(107)
A Group Is Less Productive Than Writing Alone	25	(27)	20	(68)
Difficult To Judge	4	(4)	2	(5)
I Only Write Alone	24	(26)	15	(50)

people in the U.S. group was $\bar{X} = 3.21$. Twenty-seven percent of the Dutch respondents worked in an average (mean) number of 2.87 groups, each group containing an average of 3.47 people. Thirty-eight percent of the U.S. respondents worked in an average (mean) number of 2.82 groups, each group containing an average ($\bar{X}$) of 3.03 people.

Table 8. Production of Written Technical Communications as a Function of Number of Groups and Group Size For Dutch and U.S. Aerospace Engineers and Scientists

	Netherlands		U.S.	
	%	(n)	%	(n)
Worked With Same Group				
Yes	49	(53)	47	(161)
No	27	(30)	38	(129)
I Only Write Alone	24	(26)	15	(50)
Number of People in Group				
Mean	4.96	(53)	3.21	(161)
Median	3.00	(53)	3.00	(161)
Number of Groups				
Mean	2.87	(30)	2.82	(129)
Median	2.00	(30)	3.00	(129)
Number of People in Each Group				
Mean	3.47	(30)	3.03	(129)
Median	3.00	(30)	3.00	(129)

From a prepared list, both groups were asked to indicate the number of times they had prepared, either alone or as a member of a group, specific technical information products. As individual authors, the Dutch respondents most frequently **prepared** letters, memoranda, drawings/specifications, audio/visual materials, and technical ta`ks/presentations (table 9). As part of a working group, these Dutch aerospace engineers and scientists most frequently **prepared** letters, trade/promotional literature, drawings/specifications, in-house technical reports, and conference/meeting papers. For these products, the mean number of persons per group ranged from a high of $\bar{X}$ = 5.00 to a low of $\bar{X}$ = 2.29.

Table 9. Mean (Median) Number of Technical Information Products Produced in the Past 6 Months by Dutch Aerospace Engineers and Scientists

	Alone		In a Group		Average Number of Persons Per Group	
	Mean	Median	Mean	Median	Mean	Median
Abstracts	1.97	(2.00)	1.71	(1.00)	2.71	(2.50)
Journal Articles	1.80	(1.00)	1.00	(1.00)	2.33	(2.00)
Conference/Meeting Papers	1.60	(1.00)	2.39	(2.00)	3.28	(2.00)
Trade/Promotional Literature	1.56	(1.00)	4.00	(4.00)	5.00	(5.00)
Drawings/Specifications	4.04	(2.50)	2.67	(2.00)	3.17	(2.50)
Audio/Visual Material	3.28	(3.00)	1.60	(2.00)	2.60	(2.00)
Letters	15.00	(10.00)	12.71	(10.00)	2.29	(2.00)
Memoranda	4.05	(2.00)	2.25	(2.00)	2.70	(2.00)
Technical Proposals	2.46	(2.00)	2.03	(2.00)	3.32	(2.00)
Technical Manuals	1.39	(1.00)	1.73	(1.00)	3.46	(3.00)
Computer Program Documentation	2.48	(2.00)	2.11	(1.00)	3.06	(2.00)
In-house Technical Reports	2.26	(2.00)	2.50	(2.00)	2.69	(2.00)
AGARD Technical Reports	1.33	(1.00)	2.00	(2.00)	3.50	(3.50)
Technical Talks/Presentations	2.66	(2.00)	1.50	(1.00)	2.40	(2.00)

As individual authors, U.S. respondents most frequently **prepared** memoranda, letters, drawings/specifications, audio/visual materials, and technical talks/presentations (table 10). As a group, U.S. aerospace engineers and scientists most frequently prepared letters, audio/visual materials, memoranda, drawings/specifications, and technical talks/presentations. For these products, the mean number of persons per group ranged from a high of $\bar{X} = 3.50$ to a low of $\bar{X} = 2.00$.

Table 10. Mean (Median) Number of Technical Information Products Produced in the Past 6 Months by U.S. Aerospace Engineers and Scientists

	Alone		In a Group		Average Number of Persons Per Group	
	Mean	Median	Mean	Median	Mean	Median
Abstracts	1.67	(1.00)	1.81	(1.00)	2.67	(2.00)
Journal Articles	1.33	(1.00)	1.75	(1.00)	2.74	(2.00)
Conference/Meeting Papers	1.90	(1.00)	1.54	(1.00)	2.79	(3.00)
Trade/Promotional Literature	2.00	(1.00)	1.00	(1.00)	2.50	(2.50)
Drawings/Specifications	7.21	(3.00)	3.83	(3.00)	3.02	(2.00)
Audio/Visual Material	5.73	(4.00)	5.82	(2.00)	2.95	(2.00)
Letters	9.96	(6.00)	5.95	(3.00)	2.32	(2.00)
Memoranda	16.06	(9.00)	5.14	(3.50)	2.55	(2.00)
Technical Proposals	2.17	(2.00)	2.64	(1.50)	2.61	(2.00)
Technical Manuals	2.11	(1.00)	2.11	(1.00)	3.11	(3.00)
Computer Program Documentation	3.43	(2.00)	2.20	(1.50)	2.35	(2.00)
In-house Technical Reports	2.34	(2.00)	1.80	(1.00)	2.89	(2.00)
Technical Talks/Presentations	3.54	(2.00)	3.07	(2.00)	3.46	(3.00)

Abstracts, journal articles, letters, drawings/specifications, and conference/meeting papers were the technical information products most frequently **used** by these Dutch aerospace engineers and scientists (table 11). On the average, they **used** 22 abstracts, 21 journal articles, 16 letters, 16 drawings/specifications, and 12 conference/meeting papers in a 6-month period. Technical pro-

posals, technical talks/presentations, AGARD technical reports, trade/promotional literature, and audio/visual materials were the technical information products least frequently **used** by these Dutch aerospace engineers and scientists during a 6-month period.

Memoranda, letters, journal articles, abstracts, and drawings/specifications were the technical information products most frequently **used** by U.S. aerospace engineers and scientists. On the average, they **used** 25 memoranda, 17 letters, 16 journal articles, 16 abstracts, and 15 drawings/specifications during a 6-month period. Technical proposals, in-house technical reports, technical manuals, technical talks/presentations, and drawings/specifications were the technical information products least frequently **used** by U.S. aerospace engineers and scientists during a 6-month period.

Table 11. Mean (Median) Number of Technical Information Products Used in the Past 6 Months by Dutch and U.S. Aerospace Engineers and Scientists

	Netherlands		U.S.	
	Mean	Median	Mean	Median
Abstracts	22.20	(10.00)	16.45	(10.00)
Journal Articles	21.20	(10.50)	16.55	(10.00)
Conference/Meeting Papers	12.21	(5.00)	12.00	(10.00)
Trade/Promotional Literature	6.43	(5.00)	11.79	(6.00)
Drawings/Specifications	15.60	(5.00)	15.48	(5.00)
Audio/Visual Material	6.46	(4.00)	14.60	(5.00)
Letters	16.04	(10.00)	17.28	(9.00)
Memoranda	9.00	(5.00)	25.45	(10.00)
Technical Proposals	4.83	(3.00)	5.89	(2.00)
Technical Manuals	12.04	(5.00)	7.66	(5.00)
Computer Program Documentation	10.47	(5.00)	14.57	(5.00)
In-house Technical Reports	7.30	(5.00)	6.93	(5.00)
Technical Talks/Presentations	5.05	(4.00)	10.25	(6.00)

The types of technical information most frequently **produced** by the Dutch aerospace engineers and scientists included basic scientific and technical information, in-house technical

data, technical specifications, computer programs, and experimental techniques (table 12). The types of technical information least frequently **produced** by these Dutch aerospace engineers and scientists included patents and inventions, government rules and regulations, economic information, codes of standards and practices, and product and performance characteristics. Basic scientific and technical information, in-house technical data, experimental techniques, computer programs, and technical specifications were the kinds of technical information most frequently **produced** by U.S. aerospace engineers and scientists. Government rules and regulations, codes of standards and practices, economic information, patents and inventions, and product and performance characteristics were the kinds of technical information least frequently **produced** by U.S. aerospace engineers and scientists.

Table 12. Types of Information Produced by Dutch and
U.S. Aerospace Engineers and Scientists
[n = 109; 340]

	Netherlands %	U.S. %
Basic Scientific and Technical Information	76	92
Experimental Techniques	53	65
Codes of Standards and Practices	23	9
Computer Programs	62	61
In-house Technical Data	71	86
Product and Performance Characteristics	48	32
Technical Specifications	65	45
Patents and Inventions	0	25
Government Rules and Regulations	0	4
Economic Information	3	9

The types of technical information most frequently **used** by the Dutch aerospace engineers and scientists included basic scientific and technical information, in-house technical data, technical specifications, computer programs, and product and performance characteristics (table 13). The

types of technical information least frequently used by these Dutch aerospace engineers and scientists included patents and inventions, economic information, and government rules and regulations. Basic scientific and technical information, in-house technical data, computer programs, experimental techniques, and technical specifications were the types of technical information most frequently used by U.S. aerospace engineers and scientists. Patents and inventions, economic information, and codes of standards and practices were the types of technical information least frequently used by the U.S. survey participants.

Table 13. Types of Information Used by Dutch and
U.S. Aerospace Engineers and Scientists
[n = 109; 340]

	Netherlands %	U.S. %
Basic Scientific and Technical Information	90	97
Experimental Techniques	62	82
Codes of Standards and Practices	54	36
Computer Programs	73	89
In-house Technical Data	85	90
Product and Performance Characteristics	72	63
Technical Specifications	82	69
Patents and Inventions	3	12
Government Rules and Regulations	27	52
Economic Information	6	19

Content for an Undergraduate Course in Technical Communications

Dutch and U.S. survey participants were asked their opinions regarding an undergraduate course in technical communications for aerospace majors. Approximately 48% of the Dutch respondents and 71% of the U.S. respondents indicated that they had taken a course(s) in technical communications/writing. Approximately 13% of the Dutch participants had taken a course(s) as undergraduates, approximately 28% had taken a course(s) after

graduation, and about 6% had taken a course(s) both as undergraduates and after graduation. Approximately 20% of the U.S. respondents had taken a course(s) as undergraduates, approximately 19% had taken a course(s) after graduation, and 32% had taken a course(s) both as undergraduates and after graduation.

Of the 48% (52 respondents) of the Dutch engineers and scientists who had taken coursework in technical communications/writing, about 46% (50 respondents) of them indicated that doing so had helped them to communicate technical information. Of the 70% (241 respondents) of the U.S. engineers and scientists who had taken a course(s) in technical communications/writing, about 68% (233 respondents) indicated that doing so had helped them to communicate technical information.

Dutch and U.S. participants were asked their opinion regarding the desirability of undergraduate aerospace majors taking a course in technical communications. Approximately 88% (96 respondents) of the Dutch participants and 96% (276 respondents) of the U.S. participants indicated "yes," that aerospace majors should take such a course. Approximately 52% of the Dutch participants and about 80% of the U.S. participants indicated that the course should be taken for credit (table 14).

Table 14. Opinions Regarding an Undergraduate Course in Technical Communications for Aerospace Majors

	Netherlands		U.S.	
	%	(n)	%	(n)
Taken for Credit	52	(57)	90	(259)
Not Taken for Credit	17	(18)	4	(11)
Don't Know	19	(21)	2	(6)
Should Not Have to Take Course in Technical Communications	12	(13)	4	(11)

The Dutch and U.S. participants were asked if undergraduate aerospace engineering and science majors should take a course in technical communications and, if so, how the course should be offered. About 64% of the Dutch respondents indicated that the course should be taken as part of a "required" course, about 16% thought the course should be taken as part of an "elective" course, about 7% did not have an opinion, but only 12% of the Dutch respondents indicated that undergraduate aerospace engineering and science students should **not have to take** a course in technical communications/writing. About 82% of the U.S. respondents indicated that the course should be taken as part of a "required" course, about 12% thought the course should be taken as part of an "elective" course, about 2% did not have an opinion, but only 4% of the U.S. respondents indicated that undergraduate aerospace engineering and science students should **not have to take** a course in technical communications/writing. About 45% of the Dutch and 51% of the U.S. respondents thought that technical communications/writing instruction should be taken as a separate course. Thirty-one percent of the Dutch respondents and 39% of the U.S. respondents thought it should be part of an engineering course.

Dutch and U.S. respondents were asked to select from similar lists appropriate principles for inclusion in an undergraduate technical communications course for aerospace engineering and science students. Table 15 shows their responses.

Both Dutch and U.S. respondents indicated that defining the purpose of the communication, organizing information, developing paragraphs, and assessing readers' needs were more important than matters of correctness such as word choice, note-taking and quoting, and writing at the sentence level. The process-oriented concerns such as organizing

information, defining purpose, and assessing readers' needs are typically stressed in U.S. undergraduate writing courses.

The Dutch and U.S. respondents also chose from a list of specific topics appropriate mechanics to be included in an undergraduate technical communications course for aerospace

Table 15. Recommended Principles for an Undergraduate Technical Communications Course for Aerospace Majors

Principles	Netherlands		U.S.	
	%	(n)	%	(n)
Organizing Information	83	(90)	97	(329)
Defining the Communication's Purpose	89	(97)	91	(310)
Developing Paragraphs	89	(97)	87	(296)
Assessing Reader's Needs	83	(90)	87	(295)
Choosing Words	52	(57)	83	(283)
Note Taking and Quoting	41	(45)	44	(149)
Editing and Revising	62	(67)	87	(295)
Writing Sentences	60	(62)	72	(245)

majors. Their responses appear in table 16. Both groups of respondents placed references, symbols, punctuation, spelling, and abbreviations in the top five list for inclusion.

Given a list of 13 items, the Dutch and U.S. respondents were next asked to select appropriate on-the-job communications to be included in an undergraduate technical communications course. Their responses appear in table 17.

Both groups selected oral technical presentations, abstracts, use of information sources, conference/meeting papers, technical reports, technical instructions, journal articles, letters, and memoranda for inclusion, although not in the same order of appearance. It is interesting to note that more similarities than differences exist among their choices for the types of

written communications that students should learn to produce. These choices may reflect information acquisition and use patterns among aerospace professionals.

Table 16. Recommended Mechanics for an Undergraduate Technical Communications Course for Aerospace Majors

Mechanics	Netherlands		U.S.	
	%	(n)	%	(n)
References	63	(69)	80	(272)
Symbols	53	(58)	64	(218)
Punctuation	54	(59)	74	(251)
Spelling	58	(63)	55	(187)
Abbreviations	47	(51)	55	(187)
Numbers	33	(36)	48	(163)
Capitalization	31	(34)	54	(182)
Acronyms	39	(45)	52	(176)

Table 17. Recommended On-the-Job Communications To Be Taught in an Undergraduate Technical Communications Course for Aerospace Majors

On-the-Job Communications	Netherlands		U.S.	
	%	(n)	%	(n)
Oral Technical Presentations	84	(92)	92	(311)
Abstracts	82	(89)	85	(289)
Use of Information Sources	72	(78)	72	(244)
Conference/Meeting Papers	54	(59)	67	(228)
Technical Reports	86	(94)	81	(274)
Technical Instructions	63	(69)	62	(212)
Journal Articles	49	(53)	64	(217)
Letters	50	(55)	61	(208)
Technical Specifications	56	(61)	45	(152)
Literature Reviews	38	(42)	50	(169)
Memoranda	66	(72)	60	(204)
Technical Manuals	60	(65)	43	(147)
Newsletter/Paper Articles	16	(18)	15	(50)

In an attempt to validate the findings, the top 10 on-the-job communications were paired with the top five (on average) communications "produced" and "used" by the respondents (table 18).

The on-the-job communications recommended by the Dutch respondents do not appear to closely reflect the types of communications they produce and use, nor do the responses of the

Table 18. Comparison of Dutch and U.S. Responses Concerning Technical Information Products Produced, Used, and Recommended

Netherlands	U.S.
Produced	**Produced**
Letters	Memoranda
Memoranda	Letters
Drawings/Specifications	Drawings/Specifications
Audio/Visual Material	Audio/Visual Material
Technical Talks/Presentations	Technical Talks/Presentations
Used	**Used**
Abstracts	Memoranda
Journal Articles	Letters
Letters	Journal Articles
Drawings/Specifications	Abstracts
Conference/Meeting Papers	Drawings/Specifications
Recommended	**Recommended**
Technical Reports	Oral Technical Presentations
Oral Technical Presentations	Abstracts
Abstracts	Technical Reports
Use of Information Sources	Use of Information Sources
Memoranda	Conference/Meeting Papers
Technical Instructions	Journal Articles
Technical Manuals	Technical Instructions
Technical Specifications	Letters
Conference/Meeting Papers	Memoranda
Letters	Literature Reviews

U.S. respondents appear to reflect the types of communications they produce and use. It is interesting to note that although neither group places technical reports in the top five category of communications produced or used, both groups recommended that report writing be taught.

Use of Libraries and Technical Information Centers

Almost all of the respondents indicated that their organization has a library or technical information center. Unlike the U.S. respondents (9%), about 44% of the Dutch respondents indicated that the library or technical information center was located in the building where they worked. About 56% of the Dutch and 88% of the U.S. respondents indicated that the library or technical information center was outside the building in which they worked and that it was located nearby where they worked. For 56% of the Dutch, the library or technical information center was located 1.0 kilometer or less from where they worked. For about 81% of the U.S. respondents, the library or technical information center was located 1.0 mile or less from where they worked.

Respondents were asked to indicate the number of times they had visited their organization's library or technical information center in the past 6 months (table 19). Overall, the Dutch respondents used their organization's library or technical information center more than their U.S. counterparts did. The average use rate for Dutch respondents was $\bar{X} = 18.5$ during the past 6 months compared to $\bar{X} = 9.2$ for the U.S. respondents. The median 6-month use rates for the two groups were 10.0 and 4.0, respectively.

Respondents were also asked to rate the importance of their organization's library or technical information center (table 20). Importance was measured on a 5-point scale with 1 = not at all important and 5 = very important. A majority of both groups indicated that their

Table 19. Use of the Organization's Library in Past 6 Months
by Dutch and U.S. Aerospace Engineers and Scientists

Visits	Netherlands		U.S.	
	%	(n)	%	(n)
0 times	5	(5)	11	(37)
1 - 5 times	20	(22)	43	(145)
6 - 10 times	28	(30)	21	(72)
11 - 25 times	35	(38)	14	(49)
26 - 50 times	6	(7)	7	(22)
51 or more times	6	(7)	1	(4)
Does Not Have A Library	0	(0)	3	(11)
Mean	18.5		9.2	
Median	10.0		4.0	

Table 20. Importance of the Organization's Library
to Dutch and U.S. Aerospace Engineers and Scientists

	Netherlands		U.S.	
	%	(n)	%	(n)
Very Important	78.0	(85)	68.3	(232)
Neither Important nor Unimportant	15.6	(17)	15.6	(53)
Very Unimportant	6.5	(7)	12.9	(44)
Do Not Have A Library	0.0	(0)	3.2	(11)

organization's library or technical information center was important to performing their present professional duties. About 78% of the Dutch aerospace engineers and scientists indicated that their organization's library or technical information center was important or very important to performing their present professional duties. About 68% of the U.S. aerospace engineers and scientists indicated that their organization's library or technical information center was important or very important to performing their present professional duties. Approximately 6% of the Dutch and approximately 13% of the U.S. respondents

indicated that their organization's library or technical information center was not at all important to performing present professional duties.

From a list of information sources, survey participants were asked to indicate which ones they routinely used in problem solving (table 21). In addition to personal knowledge, upon which they rely greatly, the U.S. aerospace engineers and scientists in this study display information-seeking behavior patterns similar to those of U.S. engineers in general.

Table 21. Information Sources Used by Dutch and U.S. Aerospace Engineers and Scientists in Problem Solving [n = 109; 340]

	Netherlands		U.S.	
	%	(n)	%	(n)
Personal Store Of Technical Information	98	(107)	99	(337)
Spoke With A Coworker Or People Inside My Organization	98	(107)	99	(338)
Spoke With A Colleague Outside Of My Organization	79	(86)	94	(318)
Used Literature Resources Found In My Organization's Library	95	(104)	91	(310)
Spoke With A Librarian Or Technical Information Specialist	74	(81)	80	(274)

The information-seeking behavior of the Dutch respondents did not vary greatly from that of their American counterparts. U.S. participants used their personal store of technical information, coworkers in the organization, colleagues outside the organization, literature resources found in the organization's library, and a librarian or technical information specialist. Their Dutch counterparts used their personal stores of technical information, spoke with coworkers in the organization, used literature resources found in the organization's

library, spoke with a colleague outside the organization, and spoke with a librarian or technical information specialist.

Use and Importance of Computer and Information Technology

Survey participants were asked if they use computer technology to prepare technical information. Approximately 91% of the Dutch respondents use computer technology to prepare technical information. Almost all (98%) of the U.S. respondents use computer technology to prepare technical information. About 56% of the Dutch respondents and about 73% of the U.S. respondents "always" use computer technology to prepare technical information. A majority of both groups (83% and 98%) indicated that computer technology had increased their ability to communicate technical information. About 66% of the Dutch respondents and 80% of the U.S. respondents stated that computer technology had increased their ability to communicate technical information "a lot."

From a prepared list, survey respondents were asked to indicate which computer software they used to prepare written technical information (table 22). Word processing software was used most frequently by both groups. With the exception of **outliners and prompters** and **business graphics**, the U.S. respondents made slightly greater use of computer software for preparing written technical communications than did their Dutch counterparts.

Survey respondents were also given a list of information technologies and asked, "How do you view your use of the following information technologies in communicating technical information?" Their choices included "already use it"; don't use it, but may in the future"; and "don't use it and doubt if I will." (See table 23.)

Table 22. Use of Computer Software by Dutch and U.S. Aerospace Engineers and Scientists to Prepare Written Technical Communications

Software	Netherlands		U.S.	
	%	(n)	%	(n)
Word Processing	89	(97)	96	(327)
Outliners and Prompters	20	(22)	14	(46)
Grammar and Style Checkers	24	(26)	30	(103)
Spelling Checkers	74	(81)	88	(299)
Thesaurus	35	(38)	37	(127)
Business Graphics	26	(28)	15	(52)
Scientific Graphics	61	(66)	91	(308)
Desktop Publishing	19	(21)	48	(162)

Table 23. Use, Nonuse, and Potential Use of Information Technologies by Dutch and U.S. Aerospace Engineers and Scientists

Information Technologies	Already Use It		Don't Use It, But May In Future		Don't Use It, And Doubt If Will	
	Dutch %	U.S. %	Dutch %	U.S. %	Dutch %	U.S. %
Audio Tapes and Cassettes	6	13	16	30	79	57
Motion Picture Films	4	17	21	29	75	55
Videotape	25	63	42	31	33	7
Desktop/Electronic Publishing	28	60	51	32	22	8
Computer Cassettes/Cartridge Tapes	45	44	24	32	31	24
Electronic Mail	37	83	51	15	13	2
Electronic Bulletin Boards	11	36	57	48	32	17
FAX Or TELEX	95	91	4	8	1	1
Electronic Data Bases	42	56	50	40	8	4
Video Conferencing	0	37	46	54	54	10
Teleconferencing	13	53	50	40	38	7
Micrographics and Microforms	30	23	16	42	54	34
Laser Disk/Video Disk/CD-ROM	11	19	59	68	30	14
Electronic Networks	58	76	35	19	7	5

The Dutch and U.S. aerospace engineers and scientists in this study use a variety of information technologies. The percentages of "I already use it" responses ranged from a high of 95% (FAX or TELEX) to a low of 0% (videoconferencing) for the Dutch respondents. Similarly, the U.S. responses ranged from a high of 91% (FAX or TELEX) to a low of 13% (audio tapes and cassettes).

A list, in descending order, follows of the information technologies most frequently used.

Netherlands		U.S.	
FAX or TELEX	95%	FAX or TELEX	91%
Electronic Networks	58	Electronic Mail	83
Computer Cassettes/ Cartridge Tapes	45	Electronic Networks	76
Electronic Data Bases	42	Videotape	63
Electronic Mail	37	Desktop Publishing	60

A list, in descending order, follows of the information technologies "that are not currently being used but may be used in the future."

Netherlands		U.S.	
Laser Disk/Video Disk/ CD-ROM	59%	Laser Disk/Video Disk/ CD-ROM	68%
Eletronic Bulletin Boards	57	Video Conferencing	54
Desktop/Electronic Publishing*	51	Electronic Bulletin Boards	48
Electronic Mail*	51	Micrographics and Microforms	42
Electronic Data Bases*	50	Electronic Data Bases	40
Teleconferencing*	50		
Video Conferencing	46		

* Denotes tie

Use and Importance of Electronic Networks

Survey participants were asked if they use electronic networks at their workplace in performing their present duties (table 24). Approximately 65% of the Dutch respondents use

electronic networks and about 35% either do not use or do not have access to electronic networks. About 89% of the U.S. respondents use electronic networks in performing their present duties and about 11% either do not use or do not have access to electronic networks.

Table 24. Use of Electronic Networks by Dutch
and U.S. Aerospace Engineers and Scientists

Percentage of a 40-hour Work Week	Netherlands		U.S.	
	%	(n)	%	(n)
0	0.0	(0)	1.2	(4)
1 - 25	47.7	(52)	52.9	(180)
26 - 50	10.1	(11)	16.8	(57)
51 - 75	0.0	(0)	7.6	(26)
76 - 99	5.5	(6)	8.8	(30)
100	1.8	(2)	1.5	(5)
Do Not Use or Have Access to Electronic Networks	34.9	(38)	11.2	(38)
Mean	22.1		30.1	
Median	10.0		20.0	

Respondents were also asked to rate the importance of electronic networks in performing their present duties (table 25). Importance was measured on a 5-point scale with 1 = not at all important and 5 = very important. The U.S. respondents rated electronic networks almost twice as important as their Dutch counterparts did. U.S. participants were

Table 25. Importance of Electronic Networks
to Dutch and U.S. Aerospace Engineers and Scientists

	Netherlands		U.S.	
	%	(n)	%	(n)
Very Important	35.7	(39)	65.0	(221)
Neither Important nor Unimportant	21.1	(23)	11.2	(38)
Very Unimportant	8.3	(9)	12.6	(43)
Do Not Use or Have Access to Electronic Networks	34.9	(38)	11.2	(38)

less ambivalent about the importance (neither important nor unimportant) of electronic networks than were their Dutch counterparts (about 11% vs 21%). Respondents were asked how they accessed electronic networks (table 26): mainframe terminal, personal computers, and workstations. Access via personal computer was most frequently reported.

Table 26. How Dutch and U.S. Aerospace Engineers and Scientists Access Electronic Networks

	Netherlands		U.S.	
Access	%	(n)	%	(n)
Mainframe Terminal	12.8	(14)	13.5	(46)
Personal Computer	26.6	(29)	49.1	(167)
Workstation	7.3	(8)	26.2	(89)
Some Combination of the Above	18.4	(20)	a	a
Do Not Use or Have Access to Electronic Networks	34.9	(38)	11.2	(38)

[a] Not asked of U.S. participants.

Respondents using them were asked to indicate the purpose(s) for which they used electronic networks (table 27). Both the Dutch and U.S. respondents indicated that electronic file transfer, electronic mail, remote log in for design/computational tools, and connecting to geographically distant sites represented their greatest use of electronic networks. Also noticeable for both groups is the lack of electronic network use for accessing and searching library catalogs, acquiring (ordering) documents from the library, and searching (bibliographic) data bases.

Survey participants who used electronic networks were asked to identify the groups with whom they exchanged messages or files (table 28). The Dutch respondents displayed a consistent pattern of message and file exchange both within and outside of their organization.

Overall, the U.S. group exhibited higher percentages of network use for exchanging messages or files than did their Dutch counterparts. The U.S. respondents did not display as consistent a pattern of use as the Dutch respondents did.

Table 27. Use of Electronic Networks for Specific Purposes by Dutch and U.S. Aerospace Engineers and Scientists

	Netherlands		U.S.	
Purpose	%	(n)	%	(n)
Connect to geographically distant sites	36.7	(40)	53.2	(181)
Electronic mail	33.9	(37)	81.5	(277)
Electronic bulletin boards or conferences	8.3	(9)	36.8	(125)
Electronic file transfer	58.7	(64)	83.5	(284)
Log on to remote computers	37.6	(41)	63.8	(217)
Control remote equipment	9.2	(10)	8.8	(30)
Access/search the library's catalog	10.1	(11)	29.1	(99)
Order documents from the library	3.7	(4)	9.4	(32)
Search electronic (bibliographic) data bases	11.9	(13)	33.5	(114)
Information search and data retrieval	24.8	(27)	35.9	(122)
Prepare scientific and papers with colleagues at geographically distant sites	19.3	(21)	32.9	(112)

Table 28. Use of Electronic Networks by Dutch and U.S. Aerospace Engineers and Scientists to Exchange Messages or Files

	Netherlands		U.S.	
Exchange With --	%	(n)	%	(n)
Members of Own Work Group	37.6	(41)	81.5	(277)
Others In Your Organization But Not In Your Work Group	27.5	(30)	77.9	(265)
Others In Your Organization, Not In Your Work Group, At A Geographically Distant Site	33.9	(37)	56.8	(193)
People Outside Your Organization	33.0	(36)	58.8	(200)
Do Not Use or Have Access to Electronic Networks	34.9	(38)	11.2	(38)

Survey participants were asked about the likelihood of their using electronically formatted information that has traditionally appeared as paper products (table 29). Both groups are more likely to use online systems (with full text and graphics) for technical papers and CD-ROM systems (with full text and graphics) for technical papers than they are to use

Table 29. Attitudes Toward the Use of Information in Specified Formats by Dutch and U.S. Aerospace Engineers and Scientists

	Likely Use of Information in Electronic Format[a]			
	Netherlands		U.S.	
Types of Information	%	(n)	%	(n)
Data Tables/Mathematical Presentations	44.1	(48)	57.0	(194)
Computer Program Listings	51.4	(56)	55.6	(189)
Online System (with Full Text and Graphics) for Technical Papers	60.6	(66)	69.7	(237)
CD-ROM System (with Full Text and Graphics) for Technical Papers	52.3	(57)	57.6	(196)

[a] Likely use was measured on a 1 to 5 point scale with "1" being very unlikely and "5" being very likely. Percentages include combined "4" and "5" responses.

computer program listings or data tables/mathematical presentations. When asked why they would not use these information products in electronic format, the survey respondents gave the following reasons: (1) 48% of the Dutch and 27% of the U.S. group prefer print (paper) formats; (2) 18% of the Dutch and 34% of the U.S. group cited hardware or software incompatibility; and (3) less than 15% of each group indicated that lack of computer access was the reason for non-use.

Use of Foreign and Domestically Produced Technical Reports

To better understand the transborder migration of STI via the technical report, survey participants were asked about their use of foreign and domestically produced technical reports (table 30) and the importance of these reports in performing their professional duties (table 31). Both groups make the greatest use of their own technical reports (96% of the Dutch use NLR reports and 97% of the U.S. group use NASA technical reports). Other than their own reports, the Dutch use NASA (82%); AGARD (71%); German DFVLR, DLR, and MBB (69%); and British ARC and RAE (50%) technical reports.

Table 30. Use of Foreign and Domestically Produced Technical Reports by Dutch and U.S. Aerospace Engineers and Scientists

	Netherlands		U.S.	
Country/Organization	%	(n)	%	(n)
AGARD	70.6	(77)	82.2	(236)
British ARC and RAE	49.5	(54)	54.0	(155)
ESA	44.0	(48)	5.9	(17)
Indian NAL	7.3	(8)	6.3	(18)
French ONERA	43.1	(47)	41.1	(118)
German DFVLR, DLR, and MBB	68.8	(75)	36.2	(104)
Japanese NAL	11.0	(12)	11.5	(33)
Russian TaAGI	0.9	(1)	8.4	(24)
Dutch NLR	96.3	(105)	19.9	(57)
U.S. NASA	81.7	(89)	96.5	(277)

Other than their own reports, the U.S. group uses AGARD (82%) and British ARC and RAE (54%) technical reports. Neither group makes particular use of Japanese NAL, Indian NAL, or Russian TsAGI technical reports. Survey participants were also asked about their access to these technical reports series. Overall, the Dutch appear to have better access

to foreign technical reports than do their U.S. counterparts; the exception, of course, is access to NASA technical reports.

Technical report importance was measured on a 5-point scale with 1 = very unimportant and 5 = very important. Both groups were asked to rate the importance of selected foreign and domestic technical reports in performing their present professional duties. The average (mean) importance ratings are shown in table 31. The Dutch rated the importance of U.S. NASA reports ($\bar{X}$ = 3.69) second only to their own ($\bar{X}$ = 4.32) followed by German DFVLR, DLR, and MBB reports ($\bar{X}$ = 3.22) and AGARD reports ($\bar{X}$ = 3.18). The U.S. group rated NASA reports most important ($\bar{X}$ = 4.26) followed by AGARD reports ($\bar{X}$ = 3.42).

Table 31. Importance of Foreign and Domestically Produced Technical Reports to Dutch and U.S. Aerospace Engineers and Scientists

Country/Organization	Netherlands		U.S.	
	Rating[a] $\bar{X}$	(n)	Rating[a] $\bar{X}$	(n)
AGARD	3.18	(108)	3.42	(282)
British ARC and RAE	2.87	(105)	2.89	(266)
ESA	2.35	(108)	1.44	(242)
Indian NAL	1.46	(101)	1.40	(241)
French ONERA	2.36	(107)	2.25	(257)
German DFVLR, DLR, and MBB	3.22	(108)	2.20	(247)
Japanese NAL	1.57	(104)	1.63	(239)
Russian TaAGI	1.31	(97)	1.60	(231)
Dutch NLR	4.32	(109)	1.81	(246)
U.S. NASA	3.69	(108)	4.26	(285)

[a] A 1 to 5 point scale was used to measure importance with "1" being the lowest possible importance and "5" being the highest possible importance. Hence, the higher the average (mean) the greater the importance of the report series.

DISCUSSION

Given the limited purposes of this exploratory study, the overall response rates, and the research designs, no claims are made regarding the extent to which the attributes of the respondents in the studies accurately reflect the attributes of the populations being studied. A much more rigorous research design and methodology would be needed before any claims could be made. Nevertheless, the findings of the studies do permit the formulation of the following general statements regarding the technical communications practices of the aerospace engineers and scientists who participated in the two studies:

1. The ability to communicate technical information effectively is important to Dutch and U.S. aerospace engineers and scientists.

2. As the Dutch and U.S. aerospace engineers and scientists in these studies have advanced professionally, the amount of time they spend producing and working with technical communications has increased for almost one-half (45%) of the Dutch respondents and about two-thirds (65%) of the U.S. respondents.

3. The Dutch and U.S. aerospace engineers and scientists in these studies write more frequently in small groups than they write alone. A slightly higher percentage of the U.S. and Dutch respondents find collaborative writing more productive than individual writing. Both groups of respondents frequently produce the same types of materials whether they write as members of a group or as individuals.

4. Approximately 48% of the Dutch and 71% of the U.S. aerospace engineers and scientists in these studies had taken a course in technical communications; a majority of both groups indicated that such a course had helped them communicate technical information.

5. Although the percentages vary for each item, there was considerable agreement among the Dutch and U.S. aerospace engineers and scientists in these studies regarding the on-the-job communications to be included in an undergraduate technical communications course for aerospace and science students and less agreement on the appropriate principles and mechanics that should be included in such a course.

6. The Dutch and U.S. aerospace engineers and scientists in these studies make use of personal knowledge, discussions with colleagues within and outside their organization, and literature resources found within the organization's library for solving technical problems.

Neither group relies heavily on librarians or technical information specialists for information when problem solving.

7. Although important to both Dutch and U.S. aerospace engineers and scientists, libraries and technical information centers were used more by the Dutch respondents. More Dutch aerospace engineers and scientists had a library or technical information center located in their building than did their U.S. counterparts.

8. More U.S. respondents used computer technology to prepare technical information than did their Dutch counterparts although a majority of both groups indicated that computer technology had increased their ability to communicate technical information.

9. U.S. aerospace engineers and scientists made somewhat greater use of computer software than did their Dutch counterparts.

10. There were notable similarities between the two groups in terms of the information technologies presently being used and those that might be used in the future.

11. U.S. aerospace engineers and scientists made greater use of electronic networks than did their Dutch counterparts and rated the use of electronic networks twice as important as their Dutch counterparts rated electronic network use. Both groups reported similar types of use of electronic networks, which use did not include library and data base searching.

12. U.S. and Dutch respondents make the greatest use of domestically produced technical reports and rank them highly in terms of importance in performing their professional duties. The U.S. respondents indicated extensive use of AGARD reports (82%) and British ARC and RAE technical reports (54%). The Dutch also indicated extensive use of NASA reports (82%), AGARD reports (71%), German DFVLR, DLR, and MBB reports (69%), and British ARC and RAE reports (50%).

CONCLUDING REMARKS

Despite the limitations of this investigation, these findings contribute to our knowledge and understanding of the technical communications practices among aerospace engineers and scientists at the national and international levels. The findings reinforce some of the conventional wisdom regarding the nature and importance of technical communications and the amount of time that engineers and scientists devote to communicating technical information and raise questions about their use of information sources and resources,

particularly in light of current technologies. The results of this study should prove useful to R&D managers, library and information science professionals, curriculum developers, and technical communicators.

ACKNOWLEDGMENTS

The authors express their thanks to Walter R. Blados and Ir. Axel S. T. Tan for their support of this research. The authors also express their thanks to the researchers at the National Aerospace Laboratory, the NASA Ames Research Center, and the NASA Langley Research Center for their participation.

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APPENDIX A

AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT

Fact Sheet

A research study is investigating the production, transfer, and use of scientific and technical information (STI) in aerospace, a community which is becoming more interdisciplinary in nature and more international in scope. Sponsored by the National Aeronautics and Space Administration, the Aerospace Knowledge Diffusion Research Project is being conducted by the Indiana University Center for Survey Research, the NASA Langley Research Center, RPI, and selected universities in the U.S. and abroad.

This 4-phase project will provide descriptive and analytical data regarding the flow of STI at the individual, organizational, national, and international levels. It will examine both the channels used to communicate STI and the social system of the aerospace knowledge diffusion process. The results of the project should provide useful information to R&D managers, information managers, and others concerned with improving access to and utilization of STI. Phases 1 and 4 investigate the information-seeking habits and practices of U.S. and non-U.S. engineers, scientists, and engineering and science students. Phase 2 examines the industry-government interface and places particular emphasis on the role of the information intermediary in the knowledge diffusion process. Phase 3 explores the academic-government interface and places particular emphasis on the faculty-student-information intermediary relationship.

Empirically, little is known about the production, transfer, and use of aerospace STI in general and about the information-seeking behavior of engineers, scientists, and engineering and science students. Less is known about the effectiveness of information intermediaries and the roles they play in knowledge diffusion although their roles are generally assumed to be significant ones. However, a strong methodological base for measuring or assessing their effectiveness is lacking.

The ability of aerospace engineers and scientists to identify, acquire, and utilize STI is of paramount importance to the efficiency of the R&D process. An understanding of the process by which aerospace STI is communicated through certain channels over time among members of the social system would contribute to increasing productivity, stimulating innovation, and improving and maintaining the professional competence of engineers and scientists.

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APPENDIX B

NASA/DoD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT PUBLICATIONS

REPORTS

Report No.

1 PART 1	Pinelli, Thomas E.; Myron Glassman; Walter E. Oliu; and Rebecca O. Barclay. **Technical Communications in Aerospace: Results of Phase 1 Pilot Study.** Washington, DC: National Aeronautics and Space Administration. NASA TM-101534. February 1989. 106 p. (Available from NTIS 89N26772.)
1 PART 2	Pinelli, Thomas E.; Myron Glassman; Walter E. Oliu; and Rebecca O. Barclay. **Technical Communications in Aerospace: Results of a Phase 1 Pilot Study.** Washington, DC: National Aeronautics and Space Administration. NASA TM-101534. February 1989. 83 p. (Available from NTIS 89N26773.)
2	Pinelli, Thomas E.; Myron Glassman; Walter E. Oliu; and Rebecca O. Barclay. **Technical Communication in Aerospace: Results of Phase 1 Pilot Study -- An Analysis of Managers' and Nonmanagers' Responses.** Washington, DC: National Aeronautics and Space Administration. NASA TM-101625. August 1989. 58 p. (Available from NTIS 90N11647.)
3	Pinelli, Thomas E.; Myron Glassman; Walter E. Oliu; and Rebecca O. Barclay. **Technical Communication in Aerospace: Results of Phase 1 Pilot Study -- An Analysis of Profit Managers' and Nonprofit Managers' Responses.** Washington, DC: National Aeronautics and Space Administration. NASA TM-101626. October 1989. 71 p. (Available from NTIS 90N15848.)
4	Pinelli, Thomas E.; John M. Kennedy; and Terry F. White. **Summary Report to Phase 1 Respondents.** Washington, DC: National Aeronautics and Space Administration. NASA TM-102772. January 1991. 8 p. (Available from NTIS 91N17835.)
5	Pinelli, Thomas E.; John M. Kennedy; and Terry F. White. **Summary Report to Phase 1 Respondents Including Frequency Distributions.** Washington, DC: National Aeronautics and Space Administration. NASA TM-102773. January 1991. 53 p. (Available from NTIS 91N20988.)
6	Pinelli, Thomas E. **The Relationship Between the Use of U.S. Government Technical Reports by U.S. Aerospace Engineers and Scientists and Selected Institutional and Sociometric Variables.** Washington, DC: National Aeronautics and Space Administration. NASA TM-102774. January 1991. 350 p. (Available from NTIS 91N18898.)
7	Pinelli, Thomas E.; John M. Kennedy; and Terry F. White. **Summary Report to Phase 2 Respondents Including Frequency Distributions.** Washington, DC: National Aeronautics and Space Administration. NASA TM-104063. March 1991. 42 p. (Available from NTIS 91N22931.)

8 Pinelli, Thomas E.; John M. Kennedy; and Terry F. White. **Summary Report to Phase 3 Faculty and Student Respondents.** Washington, DC: National Aeronautics and Space Administration. NASA TM-104085. June 1991. 8 p. (Available from NTIS 91N24943.)

9 Pinelli, Thomas E.; John M. Kennedy; and Terry F. White. **Summary Report to Phase 3 Faculty and Student Respondents Including Frequency Distributions.** Washington, DC: National Aeronautics and Space Administration. NASA TM-104086. June 1991. 42 p. (Available from NTIS 91N25950.)

10 Pinelli, Thomas E.; John M. Kennedy; and Terry F. White. **Summary Report to Phase 3 Academic Library Respondents Including Frequency Distributions.** Washington, DC: National Aeronautics and Space Administration. NASA TM-104095. August 1991. 42 p. (Available from NTIS 91N33013.)

11 Pinelli, Thomas E.; Madeline Henderson; Ann P. Bishop; and Philip Doty. **Chronology of Selected Literature, Reports, Policy Instruments, and Significant Events Affecting Federal Scientific and Technical Information (STI) in the United States.** Washington, DC: National Aeronautics and Space Administration. NASA TM-101662. January 1992. 130 p. (Available from NTIS 92N17001.)

12 Glassman, Nanci A. and Thomas E. Pinelli. **An Initial Investigation Into the Production and Use of Scientific and Technical Information (STI) at Five NASA Centers: Results of a Telephone Survey.** Washington, DC: National Aeronautics and Space Administration. NASA TM-104173. June 1992. 80 p. (Available from NTIS 92N27170.)

13 Pinelli, Thomas E. and Nanci A. Glassman. **Source Selection and Information Use by U.S. Aerospace Engineers and Scientists: Results of a Telephone Survey.** Washington, DC: National Aeronautics and Space Administration. NASA TM-107658. September 1992. 27 p. (Available from NTIS 92N33299.)

14 Pinelli, Thomas E.; John M. Kennedy; and Terry F. White. **Engineering Work and Information Use in Aerospace: Results of a Telephone Survey.** Washington, DC: National Aeronautics and Space Administration. NASA TM-107673. October 1992. 25 p. (Available from NTIS 92N34233.)

15 Pinelli, Thomas E.; Nanci A. Glassman; Linda O. Affelder; Rebecca O. Barclay; and John M. Kennedy. **Technical Uncertainty and Project Complexity as Correlates of Information Use by U.S. Aerospace Engineers and Scientists: Results of an Explanatory Investigation.** Washington, DC: National Aeronautics and Space Administration. NASA TM-107693. August 1993. 68 p. (NTIS pending.)

16 Pinelli, Thomas E.; John M. Kennedy; and Rebecca O. Barclay. **A Comparison of the Technical Communications Practices of Russian and U.S. Aerospace Engineers and Scientists.** Washington, DC: National Aeronautics and Space Administration. NASA TM-107714. January 1993. 56 p. (Available from NTIS 93N18160.)

PAPERS

Paper No.

1 Pinelli, Thomas E.; Myron Glassman; Rebecca O. Barclay; and Walter E. Oliu. **The Value of Scientific and Technical Information (STI), Its Relationship to Research and Development (R&D), and Its Use by U.S. Aerospace Engineers and Scientists.** Paper presented at the European Forum "External Information: A Decision Tool" January 19, 1990, Strasbourg, France. (Available from AIAA 90A21931.)

2 Blados, Walter R.; Thomas E. Pinelli; John M. Kennedy; and Rebecca O. Barclay. **External Information Sources and Aerospace R&D: The Use and Importance of Technical Reports by U.S. Aerospace Engineers and Scientists.** Paper prepared for the 68th AGARD National Delegates Board Meeting, 29 March 1990, Toulouse, France. (Available from NTIS 90N30132.)

3 Kennedy, John M. and Thomas E. Pinelli. **The Impact of a Sponsor Letter on Mail Survey Response Rates.** Paper presented at the Annual Meeting of the American Association for Public Opinion Research, May 1990, Lancaster, PA. (Available from NTIS 92N28112.)

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5 Pinelli, Thomas E. and John M. Kennedy. **Aerospace Librarians and Technical Information Specialists as Information Intermediaries: A Report of Phase 2 Activities of the NASA/DoD Aerospace Knowledge Diffusion Research Project.** Paper presented at the Special Libraries Association, Aerospace Division - 81st Annual Conference, Pittsburgh, PA, June 13, 1990. (Available from AIAA 91A19804.)

6 Pinelli, Thomas E. and John M. Kennedy. **Aerospace Knowledge Diffusion in the Academic Community: A Report of Phase 3 Activities of the NASA/DoD Aerospace Knowledge Diffusion Research Project.** Paper presented at the 1990 Annual Conference of the American Society for Engineering Education - Engineering Libraries Division, Toronto, Canada, June 27, 1990. (Available from AIAA 91A19803.)

7 Pinelli, Thomas E. and John M. Kennedy. **The NASA/DoD Aerospace Knowledge Diffusion Research Project: The DoD Perspective.** Paper presented at the Defense Technical Information Center (DTIC) 1990 Annual Users Training Conference, Alexandria, VA, November 1, 1990. (Available from AIAA 91N28033.)

8 Pinelli, Thomas E.; John M. Kennedy; and Rebecca O. Barclay. **The Role of the Information Intermediary in the Diffusion of Aerospace Knowledge.** Reprinted from *Science and Technology Libraries,* Volume 11, No. 2 (Winter), 1990: 59-76. (Available from NTIS 92N28113.)

9 Eveland, J.D. and Thomas E. Pinelli. **Information Intermediaries and the Transfer of Aerospace Scientific and Technical Information (STI): A Report From the Field.** Paper commissioned for presentation at the 1991 NASA STI Annual Conference held at the NASA Marshall Space Flight Center, Huntsville, AL, April 9, 1991. (Available from NTIS 91N21959.)

10 Pinelli, Thomas E.; John M. Kennedy; and Rebecca O. Barclay. **The NASA/DoD Aerospace Knowledge Diffusion Research Project.** Reprinted from *Government Information Quarterly,* Volume 8, No. 2 (1991): 219-233. (Available from AIAA 91A35455.)

11 Pinelli, Thomas E. and John M. Kennedy. **The Voice of the User -- How U.S. Aerospace Engineers and Scientists View DoD Technical Reports.** Paper presented at the 1991 Defense Technical Information Center's (DTIC) Managers Planning Conference, Solomon's Island Holiday Inn, MD, May 1, 1991. (Available from AIAA 91A41123.)

12 Pinelli, Thomas E.; John M. Kennedy; and Rebecca O. Barclay. **The Diffusion of Federally Funded Aerospace Research and Development (R&D) and the Information-Seeking Behavior of U.S. Aerospace Engineers and Scientists.** Paper presented at the Special Libraries Association (SLA) 82nd Annual Conference, San Antonio, TX, June 11, 1991. (Available from AIAA 92A29652.)

13 Pinelli, Thomas E. **The Information-Seeking Habits and Practices of Engineers.** Reprinted from *Science & Technology Libraries,* Volume 11, No. 3, (Spring) 1991: 5-25. (Available from NTIS 92N28114.)

14 Barclay, Rebecca O.; Thomas E. Pinelli; David Elazar; and John M. Kennedy. **An Analysis of the Technical Communications Practices Reported by Israeli and U.S. Aerospace Engineers and Scientists.** Paper presented at the International Professional Communication Conference (IPCC), The Sheraton World Resort, Orlando, FL, November 1, 1991. (Available from NTIS 92N28183.)

15 Barclay, Rebecca O.; Thomas E. Pinelli; Michael L. Keene; John M. Kennedy; and Myron Glassman. **Technical Communications in the International Workplace: Some Implications for Curriculum Development.** Reprinted from *Technical Communication,* Volume 38, No. 3 (Third Quarter, August 1991): 324-335. (Available from NTIS 92N28116.)

16 Pinelli, Thomas E.; John M. Kennedy; Rebecca O. Barclay; and Terry F. White. **Aerospace Knowledge Diffusion Research.** Reprinted from *World Aerospace Technology '91: The International Review of Aerospace Design and Development,* Volume 1 (1991): 31-34. (Available from NTIS 92N28220.)

17 Pinelli, Thomas E.; Rebecca O. Barclay; John M. Kennedy; Nanci Glassman; and Loren Demerath. **The Relationship Between Seven Variables and the Use of U.S. Government Technical Reports by U.S. Aerospace Engineers and Scientists.** Paper presented at the 54th Annual Meeting of the American Society for Information Science (ASIS), The Washington Hilton & Towers, Washington, DC, October 30, 1991. (Available from NTIS 92N28115.)

18 Hernon, Peter and Thomas E. Pinelli. **Scientific and Technical Information (STI) Policy and the Competitive Position of the U.S. Aerospace Industry.** Paper presented at the 30th Aerospace Meeting of the American Institute of Aeronautics and Astronautics (AIAA), Bally's Grand Hotel, Reno, NV, January 1992. (Available from AIAA 92A28233.)

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20 Holland, Maurita P.; Thomas E. Pinelli; Rebecca O. Barclay; and John M. Kennedy. **Engineers As Information Processors: A Survey of U.S. Aerospace Engineering Faculty and Students.** Reprinted from the *European Journal of Engineering Education,* Volume 16, No. 4 (1991): 317-336. (Available from NTIS 92N28155.)

21 Pinelli, Thomas E.; Rebecca O. Barclay; Maurita P. Holland; Michael L. Keene; and John M. Kennedy. **Technological Innovation and Technical Communications: Their Place in Aerospace Engineering Curricula. A Survey of European, Japanese, and U.S. Aerospace Engineers and Scientists.** Reprinted from the *European Journal of Engineering Education,* Volume 16, No. 4 (1991): 337-351. (Available from NTIS 92N28184.)

22 Pinelli, Thomas E. **Establishing a Research Agenda for Scientific and Technical Information (STI): Focus on the User.** Paper presented at the "Research Agenda in Information Science" workshop sponsored by the Advisory Group for Aerospace Research and Development (AGARD), April 7-9 1992, Lisbon, Portugal. (Available from NTIS 92N28117.)

23 Pinelli, Thomas E.; Rebecca O. Barclay; Ann P. Bishop; and John M. Kennedy. **Information Technology and Aerospace Knowledge Diffusion: Exploring the Intermediary-End User Interface in a Policy Framework.** Reprinted from *Electronic Networking: Research, Applications and Policy.* 2:2 (Summer 1992): 31-49. (Available from NTIS 93N12007.)

24 Brinberg, Herbert R. and Thomas E. Pinelli. **A General Approach to Measuring the Value of Aerospace Information Products and Services.** Paper presented at the 31st Aerospace Sciences Meeting and Exhibits of the American Institute of Aeronautics and Astronautics (AIAA), Bally's Grand Hotel, Reno, Nevada, January 11-13, 1993. (Available from AIAA 93A17511.)

25 Kohl, John R.; Rebecca O. Barclay; Thomas E. Pinelli; Michael L. Keene; and John M. Kennedy. **The Impact of Language and Culture on Technical Communication in Japan.** Reprinted from *Technical Communication*, Volume 40, No. 1 (First Quarter, February 1993): 62-73. (Available from NTIS 93N17592.)

26 Pinelli, Thomas E.; Rebecca O. Barclay; and John M. Kennedy. **The Relationship Between Technology Policy and Scientific and Technical Information Within the U.S. and Japanese Aerospace Industries.** Paper presented at the Third Annual JICST/NTIS Conference on *How to Locate and Acquire Japanese Scientific and Technical Information*, The Nikko Hotel, San Francisco, California, March 18, 1993. (Available from NTIS 93N20111).

27 Pinelli, Thomas E.; Rebecca O. Barclay; Stan Hannah; Barbara Lawrence; and John M. Kennedy. **Knowledge Diffusion and U.S. Government Technology Policy: Issues and Opportunities for Sci/Tech Librarians.** Reprinted from *Science and Technology Libraries*, Volume 13, Number 1 (1992): 33-55. (Available from NTIS 93N20110.)

28 Pinelli, Thomas E.; Rebecca O. Barclay; Michael L. Keene; Madelyn Flammia; and John M. Kennedy. **The Technical Communication Practices of Russian and U. S. Aerospace Engineers and Scientists.** Reprinted from *IEEE Transactions on Professional Communication*, Volume 36, No. 2 (June 1993): 95-104 (NTIS pending.)

APPENDIX C
DUTCH SURVEY INSTRUMENT

Technical Communications in Aerospace: An International Perspective

An Exploratory Study Conducted in the Netherlands
at the National Aerospace Laboratory (NLR)

Phase 4 of the Aerospace Knowledge Diffusion Research Project

---

1. In your work, how important is it for you to communicate (e.g., producing written materials or oral discussions) technical information effectively? (Circle number)

   Very Unimportant 1 2 3 4 5 Very Important

2. In the past 6 months, about how many hours did you spend each week communicating technical information?

   (output) ____ hours per week writing
   ____ hours per week communicating orally

3. Compared to 5 years ago, how has the amount of time you have spent **communicating** technical information changed? (Circle number)
   1. Increased
   2. Stayed the same
   3. Decreased

4. In the past 6 months, about how many hours did you spend each week working with technical information received from others?

   (input) ____ hours per week working with written information
   ____ hours per week receiving information orally

5. As you have advanced professionally, how has the amount of time you have spent working with technical information **received from others** changed? (Circle number)
   1. Increased
   2. Stayed the same
   3. Decreased

6. What percentage of your written technical communications involve:

Writing alone	__% → (If 100% alone, go to Question 9.)
Writing with one other person	__%
Writing with a group of 2 to 5 persons	__%
Writing with a group of more than 5 persons	__%
	100%

7. In general, do you find writing as part of a group more or less productive (i.e., producing more written products or producing better written products) than writing alone? (Circle number)

   1. A group is less productive than writing alone
   2. A group is about as productive as writing alone
   3. A groups is more productive than writing alone
   4. Difficult to judge; no experience preparing technical information

8. In the past 6 months, did you work with the same group of people when producing written technical communications? (Circle number)

   1. Yes → About how many people were in the group: _____number of people

   2. No → With about how many groups did you work: _____number of groups

      ↓

      About how many people were in each group: _____number of people

9. Approximately how many times in the past 6 months did you write or prepare the following alone or in a group? (If in a group, how many people were in each group?)

Times in Past 6 Months Produced

	Alone	In a Group	
a. Abstracts	___Times	___Times	___Average No. of People
b. Journal articles	___	___	___
c. Conference/Meeting papers	___	___	___
d. Trade/Promotional literature	___	___	___
e. Drawings/Specifications	___	___	___
f. Audio/Visual materials	___	___	___
g. Letters	___	___	___
h. Memoranda	___	___	___
i. Technical proposals	___	___	___
j. Technical manuals	___	___	___
k. Computer program documentation	___	___	___
l. AGARD technical reports	___	___	___
m. In-house technical reports	___	___	___
n. Technical talks/Presentations	___	___	___

10. Approximately how many times in the past 6 months did you use the following?

a. Abstracts	__Times used in 6 months
b. Journal articles	__
c. Conference/Meeting papers	__
d. Trade/Promotional literature	__
e. Drawings/Specifications	__
f. Audio/Visual materials	__
g. Letters	__
h. Memoranda	__
i. Technical proposals	__
j. Technical manuals	__
k. Computer program documentation	__
l. AGARD technical reports	__
m. In-house technical reports	__
n. Technical talks/Presentations	__

11. What types of technical information do you *USE* in your present job? (Circle appropriate numbers)

	Yes	No
Basic scientific and technical information	1	2
Experimental techniques	1	2
Codes of standards and practices	1	2
Computer programs	1	2
Government rules and regulations	1	2
In-house technical data	1	2
Product and performance characteristics	1	2
Economic information	1	2
Technical specifications	1	2
Patents	1	2

12. What types of technical information do you *PRODUCE* (or expect to produce) in your present job? (Circle appropriate number)

	Yes	No
Basic scientific and technical information	1	2
Experimental techniques	1	2
Codes of standards and practices	1	2
Computer programs	1	2
Government rules and regulations	1	2
In-house technical data	1	2
Product and performance characteristics	1	2
Economic information	1	2
Technical specifications	1	2
Patents	1	2

15. Have you ever taken a course in technical communications/writing? (Circle the appropriate number)

1. Yes, as an undergraduate
2. Yes, after graduation
3. Yes, both
4. Presently taking
5. No

16. How much did this course help you to communicate technical information? (Circle the appropriate number)

1. A lot
2. A little
3. Not at all

17. Do you think that undergraduate aerospace engineering and science students should have training or course work in technical communications (e.g., technical writing/oral presentations)? (Circle the appropriate number)

1. Yes
2. No
3. Don't know

→ Go to Question 21.

If you answered "yes" to Question 17, please answer Questions 18, 19, and 20.

18. Do you think a technical communications course for undergraduate aerospace engineering and science students should be: (Circle the appropriate number)

1. Taken for academic credit
2. Not taken for academic credit
3. Don't know

19. Do you think the technical communications course should be: (Circle the appropriate number)

   1. Taken as part of a required course
   2. Taken as part of an elective course
   3. Don't know

20. Do you think the technical communications course should be: (Circle the appropriate number)

   1. Taken as part of an engineering course (e.g., Engineering 201)
   2. Taken as a separate course (e.g., Technical Writing 101)
   3. Taken as part of another course (i.e., neither Engineering or English)
   4. Don't know

21. Which of the following **principles** should be included in an undergraduate technical communications course for aerospace engineers and scientists? (Circle the appropriate numbers)

	Yes	No
Defining the purpose of the communication	1	2
Assessing the needs of the reader	1	2
Organizing information	1	2
Developing paragraphs (introductions, transitions, and conclusions)	1	2
Writing sentences	1	2
Notetaking and quoting	1	2
Editing and revising	1	2
Choosing words (avoiding wordiness, jargon, slang, sexist terms)	1	2
Other (specify) ____________________		

22. Which of the following **mechanics** should be included in an undergraduate technical communications course for aerospace engineers and scientists? (Circle the appropriate numbers)

	Yes	No
Abbreviations	1	2
Acronyms	1	2
Capitalization	1	2
Numbers	1	2
Punctuation	1	2
References	1	2
Spelling	1	2
Symbols	1	2
Other (specify) ____________________		

23. Which of the following on-the-job skills should be included in an undergraduate technical communications course for aerospace engineers and scientists? (Circle the appropriate numbers)

	Yes	No
Abstracts	1	2
Letters	1	2
Memoranda	1	2
Technical instructions	1	2
Journal articles	1	2
Conference/Meeting papers	1	2
Literature reviews	1	2
Technical manuals	1	2
Newsletter/newspaper articles	1	2
Oral (technical) presentations	1	2
Technical specifications	1	2
Technical reports	1	2
Use of information sources	1	2
Other (specify) ________		

24. Do you use computer technology to prepare technical information? (Circle the appropriate number)

1. Always
2. Usually
3. Sometimes
4. Never → Go to Question 27.

If you answered "never" to Question 24, please skip to Question 27, otherwise, please answer Question 25.

25. How much has computer technology increased your ability to communicate technical information? (Circle the appropriate number)

1. Yes, a lot
2. Yes, a little
3. No, not really
4. No, not at all

26. Do you use any of the following software to prepare written technical information? (Circle the appropriate numbers)

	Yes	No
Word processing	1	2
Outliners and prompters	1	2
Grammar and style checkers	1	2
Spelling checkers	1	2
Thesaurus	1	2
Business graphics	1	2
Scientific graphics	1	2
Desktop publishing	1	2

27. How do you view your use of the following electronic/information technologies in communicating technical information? (Circle the appropriate number)

Information Technologies	I already use it	I don't use it, but may in the future	I don't use it and doubt if I will
Audio tapes and cassettes	1	2	3
Motion picture film	1	2	3
Video tape	1	2	3
Desk top/electronic publishing	1	2	3
Computer cassette/cartridge tapes	1	2	3
Electronic Mail	1	2	3
Electronic bulletin boards	1	2	3
FAX or TELEX	1	2	3
Electronic data bases	1	2	3
Video conferencing	1	2	3
Teleconferencing	1	2	3
Micrographics & microforms	1	2	3
Laser disc/video disc/CD-ROM	1	2	3
Electronic networks	1	2	3

28. At your work place, do you use electronic networks in performing your present duties?

1. Yes
2. No
3. No because I do not have access to electronic networks

→ Go to Question 34.

If you answered "yes" to Question 28, please answer Questions 29, 30, 31, 32, and 33.

29. At your work place, how do you access electronic networks?

1. By using a mainframe terminal
2. By using a personal computer
3. By using a workstation

30. How important is the use of electronic networks to performing your present duties?

Very Unimportant 1 2 3 4 5 Very Important

31. Based on a 40-hour work week, what percentage of your time do you use electronic networks?

______Percentage of the past work week

32. Do you use electronic networks for the following purposes?

	Yes	No
1. To connect to geographically distant sites	1	2
2. For electronic mail	1	2
3. For electronic bulletin boards or conferences	1	2
4. For electronic file transfer	1	2
5. To log into remote computers for such things as computational analysis or to use design tools	1	2
6. To control remote equipment such as laboratory instruments or machine tools	1	2
7. To access/search the library's catalogue	1	2
8. To order documents from the library	1	2
9. To search electronic (bibliographic) data bases (e.g., ESA)	1	2
10. For information search and data retrieval	1	2
11. To prepare scientific and technical papers with colleagues at geographically distant sites	1	2

33. Do you exchange electronic messages or files with:

	Yes	No
1. Members of your work group	1	2
2. Other people in your organization (at the same geographic site) who are not in your work group	1	2
3. Other people in your organization (at a geographically different site) who are not in your work group	1	2
4. People outside of your organization	1	2

34. How likely would you be to use the following information if it was available in electronic format?

	Very Unlikely				Very Likely
1. Data tables/mathematical presentations	1	2	3	4	5
2. Computer program listings	1	2	3	4	5
3. Online system (with full text and graphics) for technical papers	1	2	3	4	5
4. CD-ROM system (with full text and graphics) for technical reports	1	2	3	4	5

35. Which of the following best explains why you would not be using these materials in electronic format?

1. No/limited computer access
2. Hardware/software incompatibility
3. Prefer printed format
4. Other (specify) ______________________________

36. Does your organization have a library/technical information center? (Circle the appropriate number)

1. Yes, in my building
2. Yes, but not in my building → ____Km
3. No → Go to Question 39.

If you answered "yes" to Question 36, please answer Questions 37 and 38.

37. In the past six months, about how often did you use your organization's library/technical information center?

____Number of times in past 6 months

38. In terms of performing your present professional duties, how important is your organization's library/technical information center? (Circle the appropriate number)

Not at all important 1 2 3 4 5 Very important

39. When faced with solving a technical problem, which of the following sources do you usually consult?

Please sequence these items (e.g., #1, #2, #3, #4, #5) and put an X beside the steps you did not use.

Sequence

____Used my personal store of technical information, including sources I keep in my office

____Spoke with co-workers or people inside by organization

____Spoke with colleagues outside my organization

____Spoke with a librarian or technical information specialist

____Used literature resources (e.g., conference papers, journals, technical reports) found in my organization's library)

(If you used none of the above steps, check here____.)

40. Do you use the following technical reports in performing your present professional duties? (Circle numbers)

		Yes	No	Don't Have Access
1	AGARD reports	1	2	9
2	British ARC and RAE reports	1	2	9
3	ESA reports	1	2	9
4	Indian NAL	1	2	9
5	French ONERA reports	1	2	9
6	German DFVLR, DLR, and MBB reports	1	2	9
7	Japanese NAL reports	1	2	9
8	Russian TsAGI reports	1	2	9
9	Dutch NLR reports	1	2	9
10	U.S. NASA reports	1	2	9

41. How important are these reports in performing your present professional duties? (Circle numbers)

		Very Unimportant				Very Important	Don't Have Access
1	AGARD reports	1	2	3	4	5	9
2	British ARC and RAE reports	1	2	3	4	5	9
3	ESA reports	1	2	3	4	5	9
4	Indian NAL	1	2	3	4	5	9
5	French ONERA reports	1	2	3	4	5	9
6	German DFVLR, DLR, and MBB reports	1	2	3	4	5	9
7	Japanese NAL reports	1	2	3	4	5	9
8	Russian TsAGI reports	1	2	3	4	5	9
9	Dutch NLR reports	1	2	3	4	5	9
10	U.S. NASA reports	1	2	3	4	5	9

42. Your native language:

_______________ Please specify

43. How well do you read the following languages: (Circle numbers)

		Passably				Fluently	Do not Read This Language
1	English	1	2	3	4	5	9
2	French	1	2	3	4	5	9
3	German	1	2	3	4	5	9
4	Japanese	1	2	3	4	5	9
5	Russian	1	2	3	4	5	9
6	Other (please specify) _______________						

44. How well do you speak the following languages: (Circle numbers)

		Passably				Fluently	Do not Speak This Language
1	English	1	2	3	4	5	9
2	French	1	2	3	4	5	9
3	German	1	2	3	4	5	9
4	Japanese	1	2	3	4	5	9
5	Russian	1	2	3	4	5	9
6	Other (please specify) _______________						

These data will be used to determine whether people with different backgrounds have different technical communication practices.

45. Sex:

1. Female
2. Male

Over (please) →

46. Education:

1. No degree
2. Bachelor
3. Master
4. Doctorate
5. Other (specify) __________

47. Years of professional aerospace work experience:

______years

48. Type of organization where you work: (Circle ONLY ONE number)

1. Academic
2. Industrial
3. Not-for-profit
4. Government
5. Other (specify) __________

49. Which of the following BEST describes your primary professional duties? (Circle ONLY ONE number)

01 Research
02 Administration/Mgt
03 Design/Development
04 Teaching/Academic (may include research)
05 Manufacturing/Production
06 Private consultant
07 Service/Maintenance
08 Marketing/Sales
09 Other (specify) __________

50. Was your academic preparation as an:

1. Engineer
2. Scientist
3. Other (specify) ________

51. In your present job, do you consider yourself primarily an:

1. Engineer
2. Scientist
3. Other (specify) ________

52. Are you a member of a professional (national) engineering, scientific, or technical society?

1. Yes
2. No

APPENDIX D
U.S. SURVEY INSTRUMENT

Technical Communications in Aerospace: An International Perspective

An Exploratory Study Conducted at the NASA Langley Research Center

Phase 4 of the Aerospace Knowledge Diffusion Research Project

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1. In your work, how important is it for you to communicate (e.g., producing written materials or oral discussions) technical information effectively? (Circle number)

   Very Unimportant 1 2 3 4 5 Very Important

2. In the past 6 months, about how many hours did you spend each week communicating technical information?

   (output) ____ hours per week writing

   ____ hours per week communicating orally

3. In the past 6 months, about how many hours did you spend each week working with technical information received from others?

   (input) ____ hours per week working with written information

   ____ hours per week receiving information orally

4. Compared to 5 years ago, how has the amount of time you have spent **communicating** technical information changed? (Circle number)

   1. Increased
   2. Stayed the same
   3. Decreased

5. As you have advanced professionally, how has the amount of time you have spent working with technical information **received from others** changed? (Circle number)

   1. Increased
   2. Stayed the same
   3. Decreased

6. What percentage of your written technical communications involve:

Writing alone	__%	⟶ (If 100% alone, skip to question 9.)
Writing with one other person	__%	
Writing with a group of 2 to 5 persons	__%	
Writing with a group of more than 5 persons	__%	
	100%	

7. In general, do you find writing as part of a group more or less productive (i.e., quantity/quality) than writing alone? (Circle number)

   1. A group is less productive than writing alone
   2. A group is about as productive as writing alone
   3. A groups is more productive than writing alone
   4. Difficult to judge; no experience preparing technical information

8. In the past 6 months, did you work with the same group of people when producing written technical communications? (Circle number)

   1. Yes ⟶ About how many people were in the group: _____number of people

   2. No ⟶ With about how many groups did you work: _____number of groups

      ↓

      About how many people were in each group: _____number of people

9. Approximately how many times in the past 6 months did you write or prepare the following alone or in a group? (If in a group, how many people were in each group?)

	Times in Past 6 Months Produced		
	Alone	In a group	
a. Abstracts	___times	___times	___Average No. of people
b. Journal articles	___	___	___
c. Conference/Meeting papers	___	___	___
d. Trade/Promotional literature	___	___	___
e. Drawings/Specifications	___	___	___
f. Audio/Visual materials	___	___	___
g. Letters	___	___	___
h. Memoranda	___	___	___
i. Technical proposals	___	___	___
j. Technical manuals	___	___	___
k. Computer program documentation	___	___	___
l. AGARD technical reports	___	___	___
m. U.S. Government technical reports	___	___	___
n. In-house technical reports	___	___	___
o. Technical talks/Presentations	___	___	___

10. Approximately how many times in the past 6 months did you use the following?

a. Abstracts	___Times used in 6 months
b. Journal articles	___
c. Conference/Meeting papers	___
d. Trade/Promotional literature	___
e. Drawings/Specifications	___
f. Audio/Visual materials	___
g. Letters	___
h. Memoranda	___
i. Technical proposals	___
j. Technical manuals	___
k. Computer program documentation	___
l. AGARD technical reports	___
m. U.S. Government technical reports	___
n. In-house technical reports	___
o. Technical talks/Presentations	___

11. What types of technical information do you *USE* in your present job? (Circle appropriate numbers)

	Yes	No
Basic scientific and technical information	1	2
Experimental techniques	1	2
Codes of standards and practices	1	2
Computer programs	1	2
Government rules and regulations	1	2
In-house technical data	1	2
Product and performance characteristics	1	2
Economic information	1	2
Technical specifications	1	2
Patents	1	2

12. What types of technical information do you *PRODUCE* (or expect to produce) in your present job? (Circle appropriate number)

	Yes	No
Basic scientific and technical information	1	2
Experimental techniques	1	2
Codes of standards and practices	1	2
Computer programs	1	2
Government rules and regulations	1	2
In-house technical data	1	2
Product and performance characteristics	1	2
Economic information	1	2
Technical specifications	1	2
Patents	1	2

15. Have you ever taken a course in technical communications/writing? (Circle the appropriate number)

1. Yes, as an undergraduate →
2. Yes, after graduation
3. Yes, both
4. Presently taking
5. No

↓

16. How much did this course help you to communicate technical information? (Circle the appropriate number)

↓

1. A lot
2. A little
3. Not at all

17. Do you think that undergraduate aerospace engineering and science students should take a course in technical communications? (Circle the appropriate number)

1. Yes
2. No
3. Don't know

If you answered "no" or "don't know" to Question 17, please skip to Question 21. If you answered "yes" to Question 17, please continue to Question 18.

18. Do you think a technical communications course for undergraduate aerospace engineering and science students should be: (Circle the appropriate number)

1. Taken for credit
2. Not taken for credit
3. Don't know

If you answered "not taken" or "don't know" to Question 18, please skip to Question 21. If you answered "taken" to Question 18, please answer Question 19.

19. Do you think the technical communications course should be: (Circle the appropriate number)

1. Taken as part of a required course
2. Taken as part of an elective course
3. Don't know

If you think the technical communications course should be taken as a separate course, please answer Question 20. Otherwise, please skip to Question 21.

20. Do you think the technical communications course should be: (Circle the appropriate number)

1. Taken as part of an engineering course
2. Taken as a separate course
3. Taken as part of another course
4. Don't know

21. Which of the following **principles** should be included in an undergraduate technical communications course for aerospace engineers and scientists? (Circle the appropriate numbers)

	Yes	No
Defining the purpose of the communication	1	2
Assessing the needs of the reader	1	2
Organizing information	1	2
Developing paragraphs (introductions, transitions, and conclusions)	1	2
Writing sentences	1	2
Notetaking and quoting	1	2
Editing and revising	1	2
Choosing words (avoiding wordiness, jargon, slang, sexist terms)	1	2
Other (specify) ______________		

22. Which of the following **mechanics** should be included in an undergraduate technical communications course for aerospace engineers and scientists? (Circle the appropriate numbers)

	Yes	No
Abbreviations	1	2
Acronyms	1	2
Capitalization	1	2
Numbers	1	2
Punctuation	1	2
References	1	2
Spelling	1	2
Symbols	1	2
Other (specify) ______________		

23. Which of the following on-the-job skills should be included in an undergraduate technical communications course for aerospace engineers and scientists? (Circle the appropriate numbers)

	Yes	No
Abstracts	1	2
Letters	1	2
Memoranda	1	2
Technical instructions	1	2
Journal articles	1	2
Conference/Meeting papers	1	2
Literature reviews	1	2
Technical manuals	1	2
Newsletter/newspaper articles	1	2
Oral (technical) presentations	1	2
Technical specifications	1	2
Technical reports	1	2
Use of information sources	1	2
Other (specify) ____________		

24. Do you use computer technology to prepare technical information? (Circle the appropriate number)

1. Always
2. Usually
3. Sometimes
4. Never

If you answered "never" to Question 24, please skip to Question 27, otherwise, please answer Question 25.

25. How much computer technology increased your ability to communicate technical information? (Circle the appropriate number)

1. Yes, a lot
2. Yes, a little
3. No, not really
4. No, not at all

26. Do you use any of the following software to prepare written technical information? (Circle the appropriate numbers)

	Yes	No
Word processing	1	2
Outliners and prompters	1	2
Grammar and style checkers	1	2
Spelling checkers	1	2
Thesaurus	1	2
Business graphics	1	2
Scientific graphics	1	2
Desktop publishing	1	2

27. How do you view your use of the following electronic/information technologies in communicating technical information? (Circle the appropriate number)

Information Technologies	I already use it	I don't use it, but may in the future	I don't use it and doubt if I will
Audio tapes and cassettes	1	2	3
Motion picture film	1	2	3
Video tape	1	2	3
Desk top/electronic publishing	1	2	3
Computer cassette/cartridge tapes	1	2	3
Electronic Mail	1	2	3
Electronic bulletin boards	1	2	3
FAX or TELEX	1	2	3
Electronic data bases	1	2	3
Video conferencing	1	2	3
Teleconferencing	1	2	3
Micrographics & microforms	1	2	3
Laser disc/video disc/CD-ROM	1	2	3
Electronic networks	1	2	3

28. At your work place, do you use electronic networks in performing your present duties?

1. Yes
2. No
3. No because I do not have access to electronic networks

If you answered "no" to Question 28, please skip to Questior 34. If you answered "yes" to Question 28, please continue to Question 29.

29. At your work place, how do you access electronic networks?

1. By using a mainframe terminal
2. By using a personal computer
3. By using a workstation

30. How important is the use of electronic networks to performing your preser, duties?

Very Unimportant 1 2 3 4 5 Very Important

31. Based on a 40-hour work week, what percentage of your time do you use electronic networks?

______Percentage of the past work week

32. Do you use electronic networks for the following purposes?

	Yes	No
1. To connect to geographically distant sites	1	2
2. For electronic mail	1	2
3. For electronic bulletin boards or conferences	1	2
4. For electronic file transfer	1	2
5. To log into remote computers for such things as computational analysis or to use design tools	1	2
6. To control remote equipment such as laboratory instruments or machine tools	1	2
7. To access/search the library's catalogue	1	2
8. To order documents from the library	1	2
9. To search electronic data bases (e.g., RECON)	1	2
10. For information search and data retrieval	1	2
11. To prepare scientific and technical papers which colleagues at geographically distant sites	1	2

33. Do you exchange electronic messages or files with:

	Yes	No
1. Members of your work group	1	2
2. Other people in your organization (at the same geographic site) who are not in your work group	1	2
3. Other people in your organization (at a geographically different site) who are not in your work group	1	2
4. People outside of your organization	1	2

34. How likely would you be to use the following information if it was available in electronic format?

	Very Unlikely				Very Likely
1. Data tables/mathematical presentations	1	2	3	4	5
2. Computer program listings	1	2	3	4	5
3. Online system (with full text and graphics) for NASA technical papers	1	2	3	4	5
4. CD-ROM system (with full text and graphics) for NASA technical reports	1	2	3	4	5

35. Which of the following best explains why you would not be using these materials in electronic format?

1. No/limited computer access
2. Hardware/software incompatibility
3. Prefer printed format
4. Other (specify) ______________________

36. Does your organization have a library/technical information center? (Circle the appropriate number)

1. Yes, in my building
2. Yes, but not in my building ⟶ ___Miles
3. No

If you answered "yes" to Question 36, please continue to Question 37. If you answered "no" to Question 36, please skip to Question 39.

37. In the past six months, about how often did you use your organization's library/technical information center?

____Number of times in past 6 months

38. In terms of performing your present professional duties, how important is your organization's library/technical information center? (Circle the appropriate number)

Not at all important 1 2 3 4 5 Very important

39. When faced with solving a technical problem, which of the following sources do you usually consult?

↑

Please sequence these items (e.g., #1, #2, #3, #4, #5) or put an X beside the steps you did not use.

Sequence

____Used my personal store of technical information, including sources I keep in my office

____Spoke with co-workers or people inside by organization

____Spoke with colleagues outside my organization

____Spoke with a librarian or technical information specialist

____Used literature resources (e.g., conference papers, journals, technical reports) found in my organization's library)

(If you used none of the above steps, check here____.)

These data will be used to determine whether people with different backgrounds have different technical communication practices.

40. Sex:

1. Female
2. Male

41. Education:
   1. No degree
   2. Bachelors
   3. Masters
   4. Doctorate
   5. Other (specify) __________

42. Years of professional aerospace work experience:

   ___years

43. Type of organization where you work: (Circle ONLY ONE number)
   1. Academic
   2. Industrial
   3. Not-for-profit
   4. Government
   5. Other (specify) __________

44. Which of the following BEST describes your primary professional duties? (Circle ONLY ONE number)

   01 Research
   02 Administration/Mgt
   03 Design/Development
   04 Teaching/Academic (may include research)
   05 Manufacturing/Production
   06 Private consultant
   07 Service/Maintenance
   08 Marketing/Sales
   09 Other (specify) __________

45. Was your academic preparation as an:
   1. Engineer
   2. Scientist
   3. Other (specify) ________

46. In your present job, do you consider yourself primarily an:
   1. Engineer
   2. Scientist
   3. Other (specify) ________

47. Are you a member of a professional (national) engineering, scientific, or technical society?
   1. Yes
   2. No

APPENDIX D
U.S. SURVEY INSTRUMENT
SUPPLEMENTAL QUESTIONS

17. Do you think that undergraduate aerospace engineering and science students should have training or course work in technical communications (e.g., technical writing/oral presentations)? (Circle the appropriate number)

    1. Yes
    2. No ⟶ STOP
    3. Don't know ⟶ STOP

    If you answered "yes" to Question 17, please answer Questions 18, 19, and 20.

18. Do you think a technical communications course for undergraduate aerospace engineering and science students should be: (Circle the appropriate number)

    1. Taken for academic credit
    2. Not taken for academic credit
    3. Don't know

19. Do you think the technical communications course should be: (Circle the appropriate number)

    1. Taken as part of a required course
    2. Taken as part of an elective course
    3. Don't know

20. Do you think the technical communications course should be: (Circle the appropriate number)

    1. Taken as part of an engineering course (e.g., Engineering 201)
    2. Taken as a separate course (e.g., Technical Writing 101)
    3. Taken as part of another course (i.e., neither Engineering or English)
    4. Don't know

40. Do you use the following technical reports in performing your present professional duties? (Circle numbers)

		Yes	No	Don't Have Access
1	AGARD reports	1	2	9
2	British ARC and RAE reports	1	2	9
3	ESA reports	1	2	9
4	Indian NAL	1	2	9
5	French ONERA reports	1	2	9
6	German DFVLR, DLR, and MBB reports . .	1	2	9
7	Japanese NAL reports	1	2	9
8	Russian TsAGI reports	1	2	9
9	Dutch NLR reports	1	2	9
10	U.S. NASA reports	1	2	9

41. How important are these reports in performing your present professional duties? (Circle numbers)

		Very Unimportant				Very Important	Don't Have Access
1	AGARD reports	1	2	3	4	5	9
2	British ARC and RAE reports	1	2	3	4	5	9
3	ESA reports	1	2	3	4	5	9
4	Indian NAL	1	2	3	4	5	9
5	French ONERA reports	1	2	3	4	5	9
6	German DFVLR, DLR, and MBB reports . . .	1	2	3	4	5	9
7	Japanese NAL reports	1	2	3	4	5	9
8	Russian TsAGI reports	1	2	3	4	5	9
9	Dutch NLR reports	1	2	3	4	5	9
10	U.S. NASA reports	1	2	3	4	5	9

42. Your native language:

_______________________ Please specify

43. How well do you read the following languages: (Circle numbers)

		Passably				Fluently	Do not Read This Language
1	English	1	2	3	4	5	9
2	French	1	2	3	4	5	9
3	German	1	2	3	4	5	9
4	Japanese	1	2	3	4	5	9
5	Russian	1	2	3	4	5	9
6	Other (please specify) _______________________						

44. How well do you speak the following languages: (Circle numbers)

		Passably				Fluently	Do not Speak This Language
1	English	1	2	3	4	5	9
2	French	1	2	3	4	5	9
3	German	1	2	3	4	5	9
4	Japanese	1	2	3	4	5	9
5	Russian	1	2	3	4	5	9
6	Other (please specify) _______________________						

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	July 1993	Technical Memorandum

4. TITLE AND SUBTITLE
A Comparison of the Technical Communications Practices of Dutch U.S. Aerospace Engineers and Scientists*

5. FUNDING NUMBERS
WU 505-90

6. AUTHOR(S)
Rebecca O. Barclay, Thomas E. Pinelli, and John M. Kennedy

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
NASA Langley Research Center
Hampton, VA 23681-0001

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
National Aeronautics and Space Administration
Washington, DC 20546-0001

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
NASA TM-108987

11. SUPPLEMENTARY NOTES
*Report number 17 under the NASA/DoD Aerospace Knowledge Diffusion Research Project.
Rebecca O. Barclay: Rensselaer Polytechnic Institute, Troy, NY; Thomas E. Pinelli: Langley Research Center, Hampton, VA; and John M. Kennedy: Indiana University, Bloomington, IN.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Unclassified–Unlimited

Subject Category 82

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
As part of Phase 4 of the *NASA/DoD Aerospace Knowledge Diffusion Research Project*, two studies were conducted that investigated the technical communications practices of Dutch and U.S. aerospace engineers and scientists. Both studies have the same seven objectives: first, to solicit the opinions of aerospace engineers and scientists regarding the importance of technical communications to their profession; second, to determine the use and production of technical communications by aerospace engineers and scientists; third, to seek their views about the appropriate content of an undergraduate course in technical communications; fourth, to determine aerospace engineers' and scientists' use of libraries, technical information centers, and on-line data bases; fifth, to determine the use and importance of computer and information technology to them; sixth, to determine their use of electronic networks; and seventh, to determine their use of foreign and domestically produced technical reports. A self-administered questionnaire was distributed to aerospace engineers and scientists at the National Aerospace Laboratory (NLR), and NASA Ames Research Center, and the NASA Langley Research Center. The completion rates for the Dutch and U.S. surveys were 55 and 61 percent, respectively. Responses of the Dutch and U.S. participants to selected questions are presented in this report.

14. SUBJECT TERMS
Knowledge diffusion; Aerospace engineer and scientist; Communication practices

15. NUMBER OF PAGES
69

16. PRICE CODE
A04

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	